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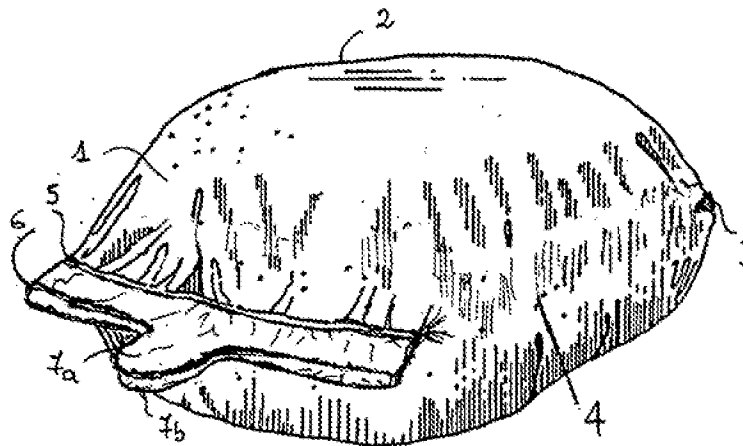
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(54) Title: **HERMETICALLY SEALABLE, EASY-OPENABLE, FLEXIBLE CONTAINER OF HEAT-SHRINKABLE THER-  
MOPLASTIC MATERIAL**



(57) **Abstract:** A plastic bag for the manufacture of an easy-openable, hermetically sealed package, comprises a multi-layer heat-shrinkable film folded and/or heat-sealed to itself to form a flexible container with two closed side edges, a closed bottom side edge and an open top side, wherein said multi-layer heat-shrinkable film comprises a first outer heat-sealing layer (a), a second outer layer (b) and directly adhered to the heat-sealing layer (a) an internal layer (c) of a blend of at least two resin components that are only partially compatible so that said layer (c) will fail when a transversal force of from about 4 to about 9.5 N/25.4 mm is applied thereto. Preferably the bag is an ES bag and comprises an unsealed area extending beyond the factory bottom seal where the front and rear panels of the bag are separately graspable and usable as tabs to be pulled apart to initiate opening of the package. Also claimed is the packaged product comprising said plastic bag.

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# HERMETICALLY SEALABLE, EASY-OPENABLE, FLEXIBLE CONTAINER OF HEAT-SHRINKABLE THERMOPLASTIC MATERIAL

## FIELD OF THE INVENTION

This invention relates to a flexible container of heat-shrinkable thermoplastic material, such as a bag or pouch, that can be sealed in a tight, hermetic manner, to encase a product, providing for a package that can withstand the conventional handling without accidentally rupturing and thus safely securing the packaged product, and at the same time can be opened by hand, i.e., without using scissors, knives, or other cutting and dangerous devices, when this is desired.

10

## BACKGROUND OF THE INVENTION

Food and other items are often packaged in flexible containers of thermoplastic material, such as pre-formed bags with one end open through which the product to be packaged is inserted into the bag, or pouches that are formed starting from a flat or folded film sealed around the product to be packaged, which are then closed by heat-sealing the open end(s).

Particularly with food products, the flexible container is very often made of heat-shrinkable thermoplastic material. In such a case, first the product is loaded into the flexible container, then air is removed and the open end of the container is closed by a heat-sealing step, and finally the sealed and vacuumized package is submitted to a heat-treatment to get the shrink of the packaging material tightly around the packaged product. While the opening of plastic bags and pouches is a problem that in general needs improving, in case of vacuumized and shrunk bags opening of the end package to reach the packaged product may become a real problem if no cutting tools are available. It is therefore desirable to provide the flexible container with so-called easy-opening means, i.e., a feature or a combination of features that would enable the end user to easily open the package by hand.

US 3,516,537 addresses this problem by creating a tab in the skirt of a heat-shrinkable bag extending beyond the factory seal of the bag, by means of a cut at a right angle to said factory seal. To open the package the tab is gripped with the fingers of one hand and pulled up and across the bottom of the package, while the packaged product is held with the other hand. The entrance edge of the tab, being directed at a right angle to the seal, will tear into and through the factory seal. As the tab is pulled across the package, the package will tear open predominantly following the sealed seam. This solution however can be employed only with products that would not be damaged by a certain pressure (such as the pressure exerted by pulling up the tab with one hand while keeping down the product with the other) such as the turkey specifically illustrated in US 3,516,537.

A similar approach, with similar drawbacks, has been described in US 3,641,732, where a laminated tear tab extending outwardly and substantially perpendicular to the package is formed by the fusion of a suitable portion of the wrapping material.

A different approach has been followed in e.g., US 3,391,851, and 5,413,412 where a tear tab is sealed over a perforation line on a heat-shrunk container or on a heat-shrinkable bag. The drawbacks in these solutions are mainly related to the risk that the accidental detachment of the adhered tear tab would expose the perforations thus leading to a loss of vacuum within the package.

Still another approach has been described in US 4,958,735 and provides for the adhesion of a thick strip of non shrinkable thermoplastic material adhered to the unshrunk portion of an otherwise shrunk package, said thick strip bearing a weakness line dividing it into two manually graspable sections to be used as tear tabs and pulled into the opposite directions to open the package. While this system has certain advantages, because for instance there is no need to keep the packaged product while opening the package and there are no risks for the packaged product if the tear tabs detach from the bag, the manufacture of such a package would be very complicated and difficult to apply

on industrial scale. Furthermore the opening of the package will occur through a tear of the shrunk film in the longitudinal direction thus destroying the whole container.

There is therefore still a need for flexible containers provided with improved easy opening means.

5

#### OBJECT AND SUMMARY OF THE INVENTION

It is thus an object of the present invention to provide an easy-openable flexible container of heat-shrinkable thermoplastic material that can be sealed in a tight, hermetic manner, to safely secure the packaged product, can be employed for the packaging of any type of products, and can be manufactured easily.

10

In a first aspect the present invention concerns a plastic bag for the manufacture of an easy-openable, hermetically sealed package, said plastic bag comprising a multi-layer heat-shrinkable film folded and/or heat-sealed to itself to form a flexible container with two closed side edges, a closed bottom side edge and an open top side, wherein said multi-layer heat-shrinkable film comprises a first outer heat-sealing layer (a), a second outer layer (b) and directly adhered to the heat-sealing layer (a) an internal layer (c) of a blend of at least two resin components that are only partially compatible so that said layer (c) will fail when a transversal force of from about 4 to about 9.5 N/25.4 mm is applied thereto.

15

As used herein the term "bag" is inclusive of end-seal (or ES) bags, which have an open top, seamless (i.e., folded, unsealed) side edges, and a seal across the bottom of the bag, transverse-seal (or TS) bags, which have an open top, a seamless bottom edge and each of the side edges with a seal therealong, and L-sealed (or LS) bags, which have an open top, a sealed bottom, one transverse-seal along a first side edge and a seamless second side edge.

20

In a preferred embodiment of this first aspect, the bag comprises an unsealed area extending beyond one of the factory seals forming the bag, where the front and rear panels of the bag itself are separately graspable and usable as tabs to be pulled apart to

initiate opening of the package. In a most preferred embodiment, said unsealed area beyond the factory seal is present only along a small portion of the seal length to further facilitate the opening of the bag by concentrating the force on a limited width of the seal.

Preferably the plastic bag is an ES bag.

5 In a second aspect the present invention concerns a packaged product comprising i) an easy-openable, hermetically sealed, plastic bag made from a multi-layer heat-shrinkable film folded and/or heat-sealed to itself to form a closed container, wherein said multi-layer heat-shrinkable film comprises at least a first outer heat-sealable layer (a), a second outer layer (b) and directly adhered to the heat-sealing layer (a) an internal  
10 layer (c) of a blend of at least two resin components that are only partially compatible so that said layer (c) will fail when a transversal force of from about 4 to about 9.5 N/25.4 mm is applied thereto, and ii) a product packaged in said bag, said plastic bag having an unsealed area extending beyond one of the seals of the package where the front and rear panels of the bag are separately graspable and usable as opening tabs.

15 In a preferred embodiment of said second aspect, the bag is an ES bag. In a more preferred embodiment the bag is an ES bag and the unsealed area is extending beyond the factory end seal and, even more preferably, said unsealed area is present only along a small portion of the bottom seal length.

Preferably in said second aspect the product is packaged under vacuum and the  
20 plastic bag is heat-shrunk around the product.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a shrunk bag according to one embodiment of the present invention where the tear tabs extend beyond the seal closing the bag mouth;

Fig. 2 is a top view of an ES bag according to a preferred embodiment of the  
25 present invention;

Fig. 3 is a top view of a tubing from which the ES bags of Fig. 2 are manufactured by using a suitably selected cutting profile;

Fig. 4 is a perspective view of a shrunk bag where the starting bag is the bag of Fig. 2;

Fig. 5 is a top view of a series of TS bags according to the present invention with a side tear tab;

5 Fig. 6a to 6c are representational top view of particular shapes of possible tear tabs.

#### DEFINITIONS

As used herein, the term "film" is used in a generic sense to include any flexible plastic web, regardless of whether it is film or sheet. Typically, films of and used in the present invention have however a thickness of 150  $\mu\text{m}$  or less, preferably a thickness of 10 140  $\mu\text{m}$  or less, and more preferably a thickness of 120  $\mu\text{m}$  or less.

As used herein, the phrases "inner layer" and "internal layer" refer to any film layer having both of its principal surfaces directly adhered to another layer of the film.

As used herein, the phrase "outer layer" refers to any film layer having only one of 15 its principal surfaces directly adhered to another layer of the film

As used herein, the phrase "innermost layer", when referred to the multi-layer film used in the manufacture of the flexible container, means the outer layer of said multi-layer film which in the end package will be closest to the packaged product relative to the other layers of the film.

20 As used herein, the phrase "outermost layer", when referred to the multi-layer film used in the manufacture of the flexible container means the outer layer of said multi-layer film which in the end package will be furthest from the packaged product relative to the other layers of the film.

As used herein, the phrases "seal layer", "sealing layer", "heat seal layer", and 25 "sealant layer", refer to an outer layer involved in the sealing of the film to itself.

As used herein the term "factory seal" refers to any and all seals necessary to convert a film tubing or a flat film into a bag having an open top. Such seals are made at the

bag-making factory and hence are herein termed to be "factory seals".

As used herein, the term "core" and the phrase "core layer", refer to any inner film layer that preferably has a function other than serving as an adhesive or compatibilizer for adhering two layers to one another.

5           As used herein, the phrase "tie layer" refers to any inner film layer having the primary purpose of adhering two layers to one another.

As used herein, the phrase "machine direction", herein abbreviated "MD", refers to a direction "along the length" of the film, i.e., in the direction of the film as the film is formed during extrusion and/or coating.

10           As used herein, the phrase "transverse direction", herein abbreviated "TD", refers to a direction across the film, perpendicular to the machine or longitudinal direction. As used herein, the phrases "heat-shrinkable," "heat-shrink," and the like, refer to the tendency of the film to shrink upon the application of heat, i.e., to contract upon being heated, such that the size of the film decreases while the film is in an unrestrained state. As used herein said  
15 term refer to films with a free shrink in each of the machine and the transverse directions, as measured by ASTM D 2732, of at least 5 % at 95 °C.

As used herein, the term "polymer" refers to the product of a polymerization reaction, and is inclusive of homo-polymers, and co-polymers, whereas the term "co-polymer" refers to polymers formed by the polymerization reaction of at least two different  
20 monomers, thus including, for example, also ter-polymers.

As used herein, the phrase "heterogeneous polymer" refers to polymerization reaction products of relatively wide variation in molecular weight and relatively wide variation in composition distribution, i.e., typical polymers prepared, for example, using conventional Ziegler-Natta catalysts.

25           As used herein, the phrase "homogeneous polymer" refers to polymerization reaction products of relatively narrow molecular weight distribution and relatively narrow composition distribution. Homogeneous polymers are structurally different from

heterogeneous polymers, in that homogeneous polymers exhibit a relatively even sequencing of co-monomers within a chain, a mirroring of sequence distribution in all chains, and a similarity of length of all chains, i.e., a narrower molecular weight distribution. This term includes those homogeneous polymers prepared using metallocene, or other single-site type catalysts, as well as those homogenous polymers that are obtained using Ziegler Natta catalysts in homogenous catalysis conditions.

As used herein, the term "polyolefin" refers to any polymerized olefin, which can be linear, branched, cyclic, aliphatic, aromatic, substituted, or unsubstituted. More specifically, included in the term polyolefin are homo-polymers of olefin, co-polymers of olefin, co-polymers of an olefin and an non-olefinic co-monomer co-polymerizable with the olefin, such as vinyl monomers, modified polymers thereof, and the like. Specific examples include polyethylene homo-polymer, polypropylene homo-polymer, polybutene homo-polymer, ethylene- $\alpha$ -olefin co-polymer, propylene- $\alpha$ -olefin co-polymer, butene- $\alpha$ -olefin co-polymer, ethylene-unsaturated ester co-polymer, ethylene-unsaturated acid co-polymer, (e.g. ethylene-ethyl acrylate co-polymer, ethylene-butyl acrylate co-polymer, ethylene-methyl acrylate co-polymer, ethylene-acrylic acid co-polymer, and ethylene-methacrylic acid co-polymer), ethylene-vinyl acetate copolymer, ionomer resin, polymethylpentene, etc.

As used herein the term "modified polyolefin" is inclusive of modified polymer prepared by co-polymerizing the homo-polymer of the olefin or co-polymer thereof with an unsaturated carboxylic acid, e.g., maleic acid, fumaric acid or the like, or a derivative thereof such as the anhydride, ester or metal salt or the like. It is also inclusive of modified polymers obtained by incorporating into the olefin homo-polymer or co-polymer, by blending or preferably by grafting, an unsaturated carboxylic acid, e.g., maleic acid, fumaric acid or the like, or a derivative thereof such as the anhydride, ester or metal salt or the like.

As used herein, the phrase "ethylene- $\alpha$ -olefin copolymer" refers to such heterogeneous materials as linear low density polyethylene (LLDPE) with a density usually in the range of from about 0.915 g/cm<sup>3</sup> to about 0.930 g/cm<sup>3</sup>, linear medium density



polyethylene (LMDPE) with a density usually in the range of from about 0.930 g/cm<sup>3</sup> to about 0.945 g/cm<sup>3</sup>, and very low and ultra low density polyethylene (VLDPE and ULDPE) with a density lower than about 0.915 g/cm<sup>3</sup>; and homogeneous polymers such as metallocene-catalyzed EXACT™ and EXCEED™ homogeneous resins obtainable from Exxon, single-site AFFINITY™ resins obtainable from Dow, and TAFMER™ homogeneous ethylene- $\alpha$ -olefin copolymer resins obtainable from Mitsui. All these materials generally include co-polymers of ethylene with one or more co-monomers selected from (C<sub>4</sub>-C<sub>10</sub>)- $\alpha$ -olefin such as butene-1, hexene-1, octene-1, etc., in which the molecules of the copolymers comprise long chains with relatively few side chain branches or cross-linked structures.

As used herein, the term "adhered", as applied to film layers, broadly refers to the adhesion of a first layer to a second layer either with or without an adhesive, a tie layer or any other layer therebetween. In contrast, as used herein, the phrase "directly adhered" is defined as adhesion of the subject layer to the object layer, without a tie layer, adhesive, or other layer therebetween. As used herein, the word "between", as applied to a layer expressed as being between two other specified layers, includes both direct adherence of the subject layer to the two other layers it is between, as well as a lack of direct adherence to either or both of the two other layers the subject layer is between, i.e., one or more additional layers can be imposed between the subject layer and one or more of the layers the subject layer is between.

As used herein the term "gas-barrier" when referred to a layer or to an overall structure, is used to identify layers or structures characterized by an Oxygen Transmission Rate (evaluated at 23°C and 0 % R.H. according to ASTM D-3985) of less than 500 cm<sup>3</sup>/m<sup>2</sup>.day.bar.

As used herein the wording "only partially compatible", when applied to the polymer components of the blend of layer (c), is intended to refer to the individual components of a polymer blend that exhibit a sufficient interfacial adhesion to held them

in contact with one another, at their interfaces, under the intended conditions of use, but that do not allow the layer containing their blend to maintain its mechanical integrity when submitted to a given stress, in this case a transversal force in the range of from about 4 to about 9.5 N/25.4 mm.

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#### DETAILED DESCRIPTION OF THE PRESENT INVENTION

The multi-layer heat-shrinkable film that can suitably be employed for the manufacture of the easy-peelable and hermetically sealable bag of the present invention contains at least three layers, a first outer heat-sealing layer (a), a second outer layer (b) and, directly adhered to the heat-sealing layer (a), an internal cohesive failure layer (c).

10

The internal cohesive failure layer (c) comprises a blend of at least two resin components that are only partially compatible and are selected in such a way that said layer (c) will fail, by an internal rupture substantially along a plane parallel to the layer itself, when a transversal force of from about 4 to about 9.5 N/25.4 mm is applied

thereto. Blends of polymer components that can be used for layer (c) are for instance  
15 those described in EP-B-192,131 comprising an ionomer with a melt flow index lower than 5 and a modified ethylene-vinyl acetate copolymer with a remarkably higher melt flow index, whereby the melt flow indices of the two polymers in said layer (c) differ by at least 10; or those described in WO 99/54398 comprising three components, i.e., a copolymer of ethylene and acrylic or methacrylic acid and in particular an ionomer, a  
20 modified EVA and a polybutene; or those described in US 2002/0172834 which comprise polybutene, an ionomer, and EVA or an alkyl ester of (meth)acrylic acid in suitable proportions, and the whole content of these documents is incorporated herein by reference.

Preferred blends for layer (c) are those comprising from about 35 wt. % to about  
25 80 wt. % of a copolymer of ethylene and acrylic or methacrylic acid and in particular an ionomer, from about 15 wt. % to about 30 wt. % of a modified ethylene-vinyl acetate, and from about 2 wt. % to about 50 wt. % of a polybutene.

Particularly preferred blends for layer (c) are those comprising from about 40 wt. % to about 70 wt. % of an ionomer, from about 15 wt. % to about 30 wt. % of a modified ethylene-vinyl acetate, such as for instance an ethylene-vinyl acetate carbon monoxide copolymer, and from about 10 wt. % to about 30 wt. % of a polybutene.

- 5 Other blends of only partially compatible resins may be employed for layer (c) provided however they will lead to a breakage of the layer when a transversal force of from about 4 to about 9.5 N/25.4 mm is applied thereto. If layer (c) does fail when a transversal force lower than about 4 N/25.4 mm is applied thereto, the bag obtained from the film containing such layer might not withstand the pressure exerted in the loading
- 10 step by the most conventional automatic loading systems and therefore there might be leakages in the packages made thereby. If layer (c) fails only when a transversal force higher than about 9.5 N/25.4 mm is applied thereto, the package obtained from the multi-layer film containing such layer (c) will not be easy-openable. The force required to break such a layer (c) is measured in accordance with ASTM F88-94 using specimens
- 15 25.4 mm in width and 300 mm in length made by heat-sealing two strips of a three-layer film where layer (c) is sandwiched between two thin polyolefin layers. The two strips are manually separated until their edges may be fixed respectively into the lower and upper clamps of an Instron dynamometer. The Instron is then started, at a crosshead speed of 30 cm/min with a full-scale load of 2 kg, and peel the specimen apart by delaminating
- 20 layer (c) into two portions.

- The heat-sealable layer (a) of the multi-layer film suitable for the manufacture of the easy-openable bag according to the present invention will comprise one or more resins independently selected from the group consisting of polyethylene homo-polymer, heterogeneous or homogeneous ethylene- $\alpha$ -olefin copolymer, ethylene-vinyl acetate co-
- 25 polymer, ethylene-ethyl acrylate co-polymer, ethylene-butyl acrylate co-polymer, ethylene-methyl acrylate co-polymer, ethylene-ethyl methacrylate co-polymer, ethylene-butyl methacrylate co-polymer, ethylene-methyl methacrylate co-polymer, ethylene-acrylic acid

co-polymer, ethylene-methacrylic acid co-polymer, ionomer and blends thereof in any proportion. Preferred resins will be ethylene-vinyl acetate copolymers, linear ethylene- $\alpha$ -olefin copolymers, homogeneous or heterogeneous, and blends of two or more of these resins. Particularly preferred resins for the heat-sealable layer (a) will comprise  
5 homogeneous and heterogeneous ethylene- $\alpha$ -olefin copolymers with a density comprised between about 0.890 and about 0.925 g/cm<sup>3</sup>, and more preferably with a density comprised between about 0.895 and about 0.915 g/cm<sup>3</sup> and blends thereof in any proportions. The preferred resins for the heat-sealable layer (a) will have a seal initiation temperature  $\leq 110$  °C, more preferably a seal initiation temperature  $\leq 105$  °C, and yet more  
10 preferably a sealing initiation temperature  $\leq 100$  °C.

Heat-sealable layer (a) will be the innermost layer in the end package and is the layer involved in the heat-sealing of the film to itself for the manufacture of the flexible container and of the end package. The thickness of said first outer layer (a) would not be higher than 20  $\mu$ m, preferably not higher than 18  $\mu$ m and even more preferably not  
15 higher than 15  $\mu$ m. Typically it will have a thickness higher than 6  $\mu$ m and preferably higher than 8  $\mu$ m to provide for a hermetic seal. Representative thickness values for the heat-sealable layer (a) are preferably in the range 10-15  $\mu$ m.

For the other outer layer (b), which will be the outermost layer in the flexible container and in the end package, any thermoplastic material can be employed, such as  
20 any polyolefin, modified polyolefin or any blend thereof. Polyamides or copolyamides and polyesters or copolyesters may also be employed.

The polyamide/copolyamide resins that could be used for the outer layer (b) may be aliphatic nylons e.g., nylon 6, nylon 11, nylon 12, nylon 66, nylon 69, nylon 610, nylon 612, and copolymer nylons including nylon 6/9, nylon 6/10, nylon 6/12, nylon  
25 6/66, nylon 6/69, and aromatic nylons, such as 6I, 6I/6T, MXD6, MXD6/MXD1 as well as blends thereof.

- Preferred thermoplastic polyesters may include those obtained from an acid component comprising an aromatic dibasic acid, such as terephthalic acid or isophthalic acid, and a glycol component comprising an aliphatic glycol, an alicyclic glycol or an aromatic glycol, such as ethylene glycol, diethylene glycol or cyclohexane dimethanol.
- 5 The use of a co-polyester, formed starting from two or three species of acid component or/and of glycol component, would be preferred.

- Preferred polyolefin resins for the outer layer (b) are ethylene homo-polymers and ethylene co-polymers. More preferred are ethylene- $\alpha$ -olefin copolymers, particularly those with a density of from about 0.895 to about 0.935 g/cm<sup>3</sup>, and more preferably of
- 10 from about 0.900 and about 0.930 g/cm<sup>3</sup>, ethylene-vinyl acetate copolymers, particularly those with a vinyl acetate content of from about 4 to about 14 % by weight, ionomers, and their blends.

- The thickness of said outer layer (b) typically will depend on the number of layers in the overall structure and on their thickness in view of the total thickness desired
- 15 for the flexible container. It will thus be generally comprised between about 2 and about 20  $\mu$ m, and preferably between about 3 and about 15  $\mu$ m.

- According to a preferred embodiment of the present invention the multi-layer film also comprises a core gas-barrier layer (d) that comprises at least one gas barrier resin generally selected from vinylidene chloride copolymers (PVDC), ethylene-vinyl
- 20 alcohol copolymers (EVOH), polyamides and acrylonitrile-based copolymers. Preferred resins are typically PVDC, EVOH, polyamides/copolyamides and blends of EVOH with polyamides/copolyamides.

- The most preferred resin is PVDC. This term includes copolymers of vinylidene chloride and at least one mono-ethylenically unsaturated monomer copolymerizable with
- 25 vinylidene chloride. The mono-ethylenically unsaturated monomer may be used in a proportion of 2-40 wt. %, preferably 4-35 wt. %, of the resultant PVDC. Examples of the mono-ethylenically unsaturated monomer may include vinyl chloride, vinyl acetate,

vinyl propionate, alkyl acrylates, alkyl methacrylates, acrylic acid, methacrylic acid, and acrylonitrile. The vinylidene chloride copolymer can also be a ter-polymer. It is particularly preferred to use a copolymer with vinyl chloride or (C<sub>1</sub>-C<sub>8</sub>)-alkyl (meth)acrylate, such as methyl acrylate, ethyl acrylate or methyl methacrylate, as the comonomers. It is also possible to use a blend of different PVDC such as for instance a blend of the copolymer of vinylidene chloride with vinyl chloride with the copolymer of vinylidene chloride with methyl acrylate. The PVDC may contain suitable additives as known in the art, i.e. stabilisers, antioxidants, plasticizers, hydrochloric acid scavengers, etc. that may be added for processing reasons or/and to control the gas-barrier properties of the resin.

Ethylene-vinyl alcohol copolymers will be preferably employed when a particularly good flexibility is required or when a fully coextruded, irradiated structure is manufactured because EVOH withstands irradiation without being degraded, up to a very high energy level. It will be used alone or admixed with a polyamide or copolyamide. Polyamides and copolyamides can also be employed alone as gas-barrier resins. Particularly preferred in this case are the aromatic polyamides/copolyamides such as the polyamide formed by polycondensation between methaxylyenediamine and adipic acid, the polyamide formed from hexamethylenediamine and terephthalic acid and/or isophthalic acid and the copolyamide formed from methaxylyenediamine, adipic acid and isophthalic acid. In general amorphous or semi-crystalline polyamides/copolyamides are preferred.

Once the gas-barrier resin has been selected, its thickness will be set to provide for the desired oxygen transmission rate (OTR). High barrier structures will have an OTR below 100 cm<sup>3</sup>/day.m<sup>2</sup>.atm and preferably below 80 cm<sup>3</sup>/day.m<sup>2</sup>.atm and will be particularly suitable for meat packaging, including fresh red meat and processed meat. Higher OTR will be preferred for packaging e.g. most of the cheeses where generally

OTR of from about 100 to about 400 cm<sup>3</sup>/day.m<sup>2</sup>.atm are preferred and from about 150 to about 350 cm<sup>3</sup>/day.m<sup>2</sup>.atm mostly preferred.

Typically the thickness of the barrier layer ranges from about 2 to about 10 μm, preferably from about 3 to about 8 μm, and more preferably from about 3.5 to about 7 μm.

Additional layers, such as for instance tie layers, to improve interlayer adhesion, may be present.

Tie layers may be disposed between the respective layers in case where a sufficient adhesion is not ensured between adjacent layers. The adhesive resin may preferably comprise one or more polyolefins, one or more modified polyolefins or a blend of the above. Specific, not limitative, examples thereof may include: ethylene-vinyl acetate copolymers, ethylene-(meth)acrylate copolymers, ethylene-α-olefin copolymers, any of the above modified with carboxylic or preferably anhydride functionalities, elastomers, and a blend of these resins.

If the structure contains tie layers their thickness is generally comprised between about 0.5 and about 7 μm, and preferably between about 2 and about 5 μm.

Other layers may be present in the overall structure such as bulky structural layers to increase the thickness of the overall structure as desired, oxygen scavenging layers, additional gas-barrier layers, etc. as known in the art.

Typically the overall thickness of the film for use in the manufacture of the flexible containers of the present invention will be between about 35 and about 120 μm, preferably between about 40 and about 110 μm, and even more preferably between about 45 and about 100 μm.

In all the film layers, the polymer components may contain appropriate amounts of additives normally included in such compositions. Some of these additives are preferably included in the outer layers or in one of the outer layers, while some others are preferably included in the outer layers or in one of the outer layers, while some others are

preferably added to inner layers. These additives include slip and anti-block agents such as talc, waxes, silica, and the like, antioxidants, stabilizers, plasticizers, fillers, pigments and dyes, cross-linking inhibitors, cross-linking enhancers, UV absorbers, antistatic agents, anti-fog agents or compositions, and the like additives known to those skilled in the art of packaging films.

The films according to the present invention are heat-shrinkable.

Preferably they show a % free shrink in each direction of at least 10 % at 95 °C. and more preferably a % free shrink at 95 °C higher than 20 in at least one direction, and even more preferably a % free shrink at 95 °C higher than 20 in each direction.

Preferred films are also those showing a % free shrink higher than 10 in each direction at a temperature of 90 °C and more preferred those showing a % free shrink higher than 10 in each direction at a temperature of 85 °C.

The films according to the present invention can be manufactured by the so-called trapped-bubble process, which is a known process typically used for the manufacture of heat-shrinkable films for food contact packaging. According to said process, the multilayer film is co-extruded through a round die to obtain a tube of molten polymeric material which is quenched immediately after extrusion without being expanded, optionally cross-linked, then heated to a temperature which is above the T<sub>g</sub> of all the resins employed and below the melting temperature of at least one of the resins employed, typically by passing it through a hot water bath, or alternatively by passing it through an IR oven or a hot air tunnel, and expanded, still at this temperature by internal air pressure to get the transversal orientation and by a differential speed of the pinch rolls which hold the thus obtained "trapped bubble", to provide the longitudinal orientation. Typical orientation ratios will be comprised between about 2 and about 6 in each direction and preferably between about 3 and about 5 in each direction. After being stretched, the film is quickly cooled while substantially retaining its stretched dimensions



to somehow freeze the molecules of the film in their oriented state and rolled for further processing.

Cross-linking is typically obtained by passing the flattened tubing through an irradiation vault where it is irradiated by high-energy electrons. Depending on the characteristics desired, this irradiation dosage can vary from about 20 to about 200 kGy, preferably from about 30 to about 150 kGy.

Depending on the number of layers in the structure it may be advisable or necessary to split the co-extrusion step: a tube will first be formed of a limited number of layers, with layer (a) on the inside of the tube; this tube will be quenched quickly and before submitting it to the orientation step it will be extrusion-coated with the remaining layers, again quenched quickly, optionally cross-linked, and then passed to the orientation. During the extrusion-coating the tube will be slightly inflated just to keep it in the form of a tube and avoid that it collapses. The coating step can then be simultaneous, by coextruding all the remaining layers altogether, so as to simultaneously adhere all of them, one over the other, to the quenched tube obtained in the first coextrusion step, or this coating step can be repeated as many times as the layers which are to be added.

The extrusion-coating step is clearly also required when a film only partially cross-linked is desired. As an example, in the case of barrier structures comprising a PVDC layer which might be degraded/dicoloured by irradiation, it might be desirable to avoid cross-linking of the PVDC layer. In this case the irradiation step will be performed after the extrusion of the first group of layers, which would not comprise the PVDC barrier layer, and before the extrusion-coating.

Alternatively, the film according to the present invention may be obtained by flat extrusion (co-extrusion or extrusion coating) and biaxial stretching by a simultaneous or a sequential tenter process.

Still alternatively the film according to the present invention may be obtained by heat- or glue-laminating separately obtained webs each containing only part of the film sequence of layers.

In a preferred embodiment the film is obtained as a seamless tubular film and it is then converted into end sealed (ES) bags by transversely sealing and severing across the seamless tubular film as it lays flat. Alternatively it is converted into transverse sealed (TS) bags by slitting the seamless tubular film along one of its edges and then transversely seal and severe the thus obtained center-folded film into bags, where the side seals are the sealing and severing seams and the bottom of the bag is the unslit edge of the film.

Other bag and pouch making methods known in the art may be readily adapted to make receptacles from the multilayer film according to the present invention.

The seal(s) along the bottom and/or side edges of the flexible containers of the invention can be at the very edge itself (e.g., seals of a type commonly referred to in this art as "trim seals" where sealing of e.g. the bottom of one bag will generate the open mouth of the following bag and in such a case the opening tabs to be grasped when opening of the package is desired, will be created in the bag portion which extends beyond the seal closing the open mouth of the package. This embodiment is illustrated in Figure 1, where 1 is the product packaged in the bag 2, 3 indicates the trim end seal, 4 is one of the seamless (folded) side edges of the ES bag, 5 is the seal closing the mouth of the bag, 6 is the skirt extending beyond seal 5 and 7a and 7b are the shaped portions of the unsealed front and rear panels of the bag which extend beyond the seal 5. By grasping said two tabs 7a and 7b and pulling them in laterally opposite directions, it will then be possible to easily initiate opening of the bag.

However, in general, the factory seals are made using an impulse-type heat-sealing apparatus which utilizes a heat-sealing bar which is quickly heated and then quickly cooled. The heat-sealing bar may be straight or possibly shaped, e.g., typically

with a curved shape, and is associated with cutting means, generally parallel to the sealing bar and at a short distance thereof. The heat-sealing means and the cutting means will operate simultaneously and while the heat-sealing means will seal the bottom of one bag, the associated cutting means will create the open mouth in the following one. This  
5 will generate bags where the seals are spaced inwardly (roughly 0.5-1.5 cm) from the container side and/or bottom edges with a so-called "skirt" of the unsealed front and rear panels extending beyond the seal and having a dimension corresponding to the distance between the sealing means and the cutting means. When a flexible container according to a preferred embodiment of the present invention is desired, where suitably shaped  
10 opening tabs of unsealed material extend beyond one of the factory seals, it will thus be sufficient to modify the profile of the cutting means accordingly, while maintaining the shape of the heat-sealing bar unchanged.

In both cases, in order to get the best results in terms of easy openability of the package, the width of the seal, be it a factory seal or the seal made in the packaging  
15 process to close the mouth of the package, will be less than about 4 mm, more preferably less than about 3.5 mm, and typically comprised between about 1 and about 3 mm, e.g., 1 to 2 mm.

With reference to the Figures, Figure 2 is a top view of an ES bag according to a preferred embodiment of the present invention. In said figure 10 is the bottom factory  
20 seal of the bag, 11 and 12 are the side folded edges, 13 is the open mouth of the bag, 14 is the skirt beyond the bottom factory seal 10 and 15 is that part of the skirt 14 where the unsealed rear and front panels (15a and 15b) are suitably shaped to be separately graspable and thus usable as opening tabs.

Figure 3 is a perspective view of a lay-flat tubing from which the bag of Figure 2  
25 is made. In said Figure 3, 20 is the seamless tubing in a lay-flat configuration, 21 and 22 are the side folded edges of the tubing, 23 is the end seal of the first bag formed 24, 25 is the skirt of the same bag 24 which extends beyond the factory seal, 26 are the opening

tabs of bag 24, i.e. the area in said skirt 25 where the two unsealed rear and front panels will be separately grasped by the user and pulled apart to open the bag 24, 27 is the mouth of the next bag 28, having the complementary shape, 29 is the end seal of bag 28, 30 is the skirt of said bag 28, and 31 are the opening tabs of bag 28.

5           Fig. 4 represents a perspective view of a package obtained from a bag according to Fig. 2, where the package is shrunk following vacuumization and heat-sealing of the bag mouth. In said Figure 4, 40 is the product packaged, 41 is the bag, 42 is the bottom factory seal, 43 is the skirt extending beyond the bottom factory seal, 44a and 44b are the two opening tabs in the rear and front panels of the shrunk bag that will be pulled in  
10           laterally opposite directions to initiate and propagate opening of the bag, 45 is one of the two folded side edges and 46 is the top seal to close the bag.

          Figure 5 is a top view of a series of TS serrated bags, where 50 is a first TS bag, 51 is the bottom folded edge, 52 is the open mouth of bag 50, 53 and 54 are the side seals of bag 50, 55 are the tabs cut into the side skirt 56 extending beyond the factory side seal  
15           53, 57 is the serration between said bag 50 and the next one 58, 59 is one side seal of bag 58, the other being indicated with numeral 60, 61 is the folded bottom edge of bag 58, and 62 is the open mouth, 63 is the tab cut into the side skirt 64 extending beyond the factory side seal 60, and 65 is the serration between said bag 58 and the next one, not illustrated in said Figure.

20           Figures 6a to 6c are top views of details of ES bags according to a preferred embodiment of the invention wherein alternative shapes of the profile of the opening tabs are illustrated. In these Figures 70a, 70b, and 70c indicate the bottom factory seal of the ES bag, 71a, 71b, and 71c are the skirt extending beyond the respective factory seals and 72a, 72b, and 72c are alternative shapes for the opening tabs in the superposed panels.

25           As illustrated in these figures, preferably the opening tabs have a limited dimension as this will allow to concentrate the force of the user to initiate breaking of the seal and therefore opening of the bag, in a direction perpendicular to the direction in

which the tabs are pulled. Preferably the opening tabs will have a size suitable to be grasped by the hands of the user and will extend beyond the factory seal only along a small portion of the factory seal length, typically not exceeding 50 %, preferably not exceeding 30 % and more preferably not exceeding 20 % of the length of the factory seal. With reference to the Figures 6a, 6b, and 6c, 73a, 73b, and 73c, indicate the length of the factory seal along which the opening tabs respectively extend. In all those cases the opening tabs are of a size suitable to allow grasping by the hands of the user, while the length of the factory seal along which they extend, as well their positioning, may vary to a great extent.

When the package has to be opened, the end user will keep the package by the opening tabs and pull them in laterally opposite directions. The seal adjacent to the tab will then be opened by breaking the heat-sealing layer (a), through the cohesive failure layer (c) in the sealing area, and again breaking the heat-sealing layer (a) below the sealing area but leaving the other layers unaffected. Thus there will be no breakage of the bag but only its opening and no encapsulation. In packaging, the product will be loaded into a heat-shrinkable bag made of the film of the invention, the bag will normally be evacuated, and the open end thereof will be closed by heat-sealing, optionally creating opening tabs in the skirt extending beyond the seal closing the open mouth, if opening tabs extending beyond any of the factory seals are not already present in the pre-formed bag. Following vacuumization and heat-sealing the packaging material will be heat shrunk by applying heat. This can be done, for instance, by immersing the filled bag into a hot water bath or conveying it through a hot water shower or a hot air tunnel, or by infrared radiation. The heat treatment will produce a tight wrapping that will closely conform to the contour of the product therein.

An easy-openable, hermetically sealable, bag according to the present invention has wide applications, particularly for food packaging applications, e.g., for the packaging of meat, such as beef and poultry, processed meat, such as ham, mortadella,

wurstel, and dairy products, particularly hard cheeses. The bag will have heat-sealing properties that will allow it to survive the process of being filled, evacuated, sealed, closed, heat shrunk, boxed, shipped, unloaded, and stored at the retail supermarket, without loosing the hermeticity, while it will also have an easy opening feature that will

5 allow opening of the package by hand, i.e., without using scissors, knives, or other cutting and dangerous devices, when this is desired.

The invention can be further understood by reference to the following examples that are merely illustrative and are not to be interpreted as a limitation to the scope of the present invention that is defined by the appended claims.

10

#### EXAMPLE

A six layer structure has been prepared by coextrusion of a substrate consisting of a first (sealing) outer layer (a), an adjacent cohesive failure layer (c), and a bulk layer (f), followed by quenching of the extruded three layer tubular film, irradiation at 64 kGy and

15 extrusion coating thereof with a barrier layer (e), an adhesive layer (d) and the outer layer (c). The end extruded tube is then rapidly cooled and biaxially oriented by passing it through a hot water bath (about 95-98°C), then inflating to get transverse orientation and stretching to get longitudinal orientation. The orientation ratios were about 3.5 x 3.5.

The resins used for the different layers and the partial thicknesses of each layer

20 are reported in the Table below.

layer	Resin or resin composition	Thickness (μm)
(a)	80 % of metallocene ethylene- $\alpha$ -olefin copolymer with $d = 0.902 \text{ g/cm}^3$ and $MI = 6 \text{ g/10 min}$ (Affinity™PL1280G) and 20 % of heterogeneous ethylene- $\alpha$ -olefin copolymer with $d = 0.911 \text{ g/cm}^3$ and $MI = 6 \text{ g/10 min}$	13

	(Stamylex™ 08-076F by DSM)	
(c)	<p>58 % of ionomer (Na methacrylate) with <math>d = 0.94</math> g/cm<sup>3</sup> and MI = 1.3 g/10 min (Surlyn® 1601 by DuPont)</p> <p>22 % of Ethylene-vinyl acetate/carbon monoxide copolymer (24% Vinyl Acetate) with <math>d = 1</math> g/cm<sup>3</sup> and MI = 35 g/10 min (Elvalloy™ 741A) and</p> <p>20 % of polybutylene with <math>d = 0.908</math> g/cm<sup>3</sup> and MI = 1 g/10 min (Polybutene-1 PB8640M by Basell)</p>	7
(f)	<p>50 % of heterogeneous ethylene-<math>\alpha</math>-olefin copolymer with <math>d = 0.920</math> g/cm<sup>3</sup> and MI = 1 g/10 min (Dowlex™ 2045E by Dow) and</p> <p>50 % of ethylene-vinyl acetate copolymer (13 wt. % VA ) MI = 0.4 g/10 min (Evatane™ 1003 VN 4 by Elf-Atochem)</p>	24
(e)	PVDC containing 2 wt. % of plasticisers and 1 wt.% of stabilizers	5
(d)	<p>80 % of maleic anhydride-modified linear low density polyethylene <math>d = 0.913</math> g/cm<sup>3</sup> and MI = 1.7 g/10min and</p> <p>20 % of ethylene-vinyl acetate modified with ethylene acrylic acid copolymer (Bynel™ 3101 by Du Pont)</p>	6
(b)	co-polyamide nylon 6/66 (85/15) (Ultramid® C35 by BASF)	3

Melt Flow Indexes (MFI's) are measured by ASTM D-1238, Condition E, 190°C/2.16 kg and are reported in grams/10 minutes.

Unless otherwise specifically indicated, all percentages are by weight.

The % free shrink at 90 °C was measured according to ASTM D 2732 by immersing for 5 seconds specimens of the structure (10 cm x 10 cm) into a hot water bath set at 90 °C and then calculating the % free shrink in each direction by the equation

$$\% \text{ free shrink} = (L_0 - L_f)/L_0 \times 100$$

5     wherein ( $L_0$  is the initial length of side and  $L_f$  is the length of side after shrinking).

The film of Example 1 showed a % free shrink (LD/TD) at 90 °C of 30/40.

The tubing of oriented material was flattened and converted into ES bags 350 mm x 500 mm, by means of an impulse sealer set at the following conditions: 160 cycle/min at 16 mA of impulse. The cut profile was modified to give bags with the opening tabs as  
10     indicated in Figure 2, the dimensions of said tabs were 80 mm in length and 60 mm in maximum width.

The seal strength of these bags has been measured by means of the Parallel Plate Burst Test. In this test each bag was confined between two metal plates based about 10 cm apart within a chamber and inflated until its seal fails. In particular each bag was  
15     clamped in a fixture provided with a hose and the open mouth of the bag was clamped around the hose. Air was pumped through the hose whereby the bag was inflated. The two metal plates restrained the two sides of each bag respectively. For each bag the pressure was increased via the hose at the rate of 1 inch of water pressure per second until the seal for that bag burst open.

20     The seal strength of these bags has also been measured by the Variable Pressure Hot Burst Test that is a test to determine the seal quality of shrinkable materials at different temperatures. The approach with this test is to immerse total sealed areas into hot water and after a predetermined dwell time, increase the pressure inside the bag at a constant rate of approximately 25.4 mm of water per second until the seal fails. The  
25     millimeters of water pressure, at the level at which the seal fails, are recorded. Minimum specifications are expressed in mm for each bag width.



The results obtained with the bags tested in the Parallel Plate Burst Test and in the Variable Pressure Hot Burst Test were respectively 170 IOWP and 100 mbar, values both perfectly in line with the product specification.

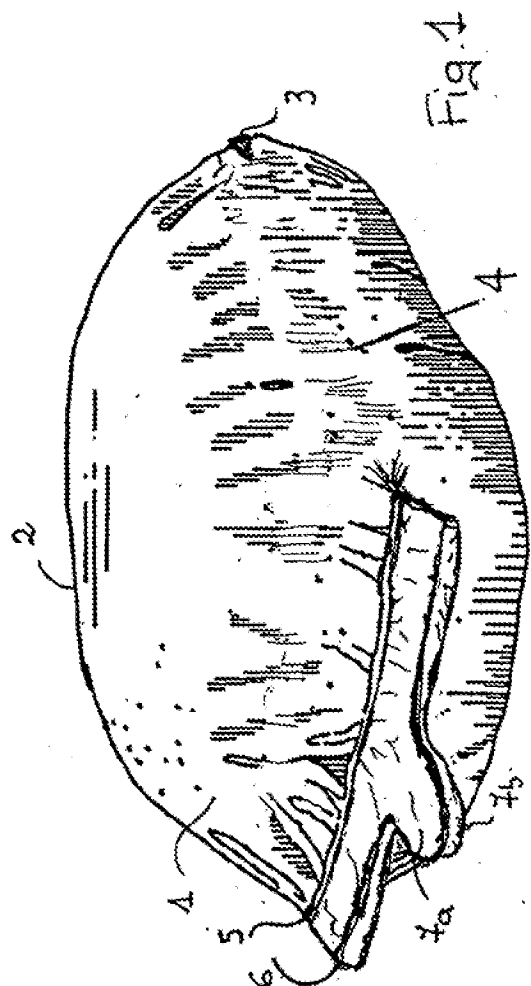
5 The easy-openability of these bags was then tested by loading them with a product (2 kg), vacuumizing in a Cryovac® VC 12 vacuum chamber, heat-sealing the open mouth and finally shrinking in hot (95 °C) water. The shrunk packages were allowed to cool, dried, and then easily opened by hands by pulling the opening tabs in the two laterally opposite directions.

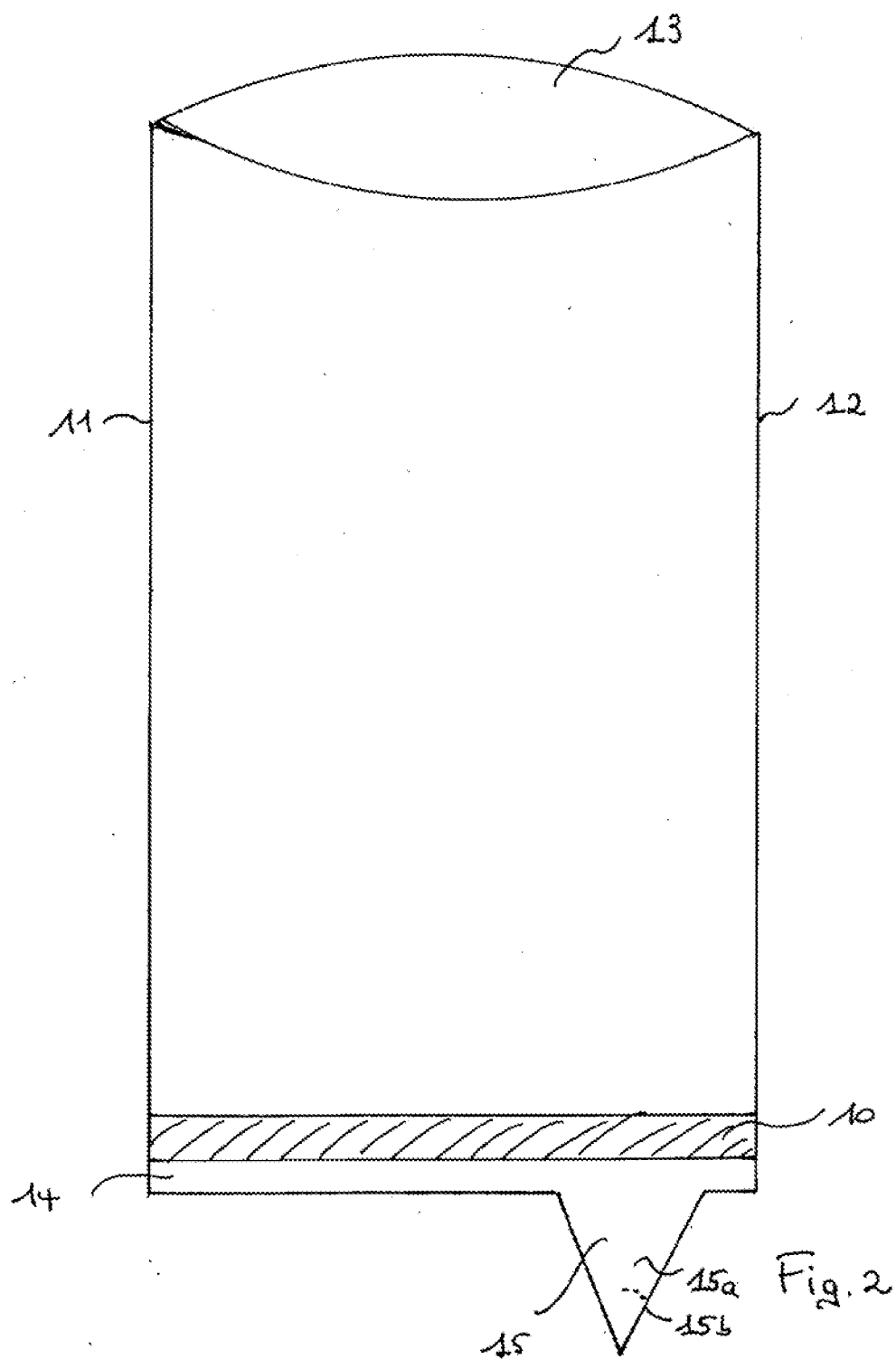
## CLAIMS

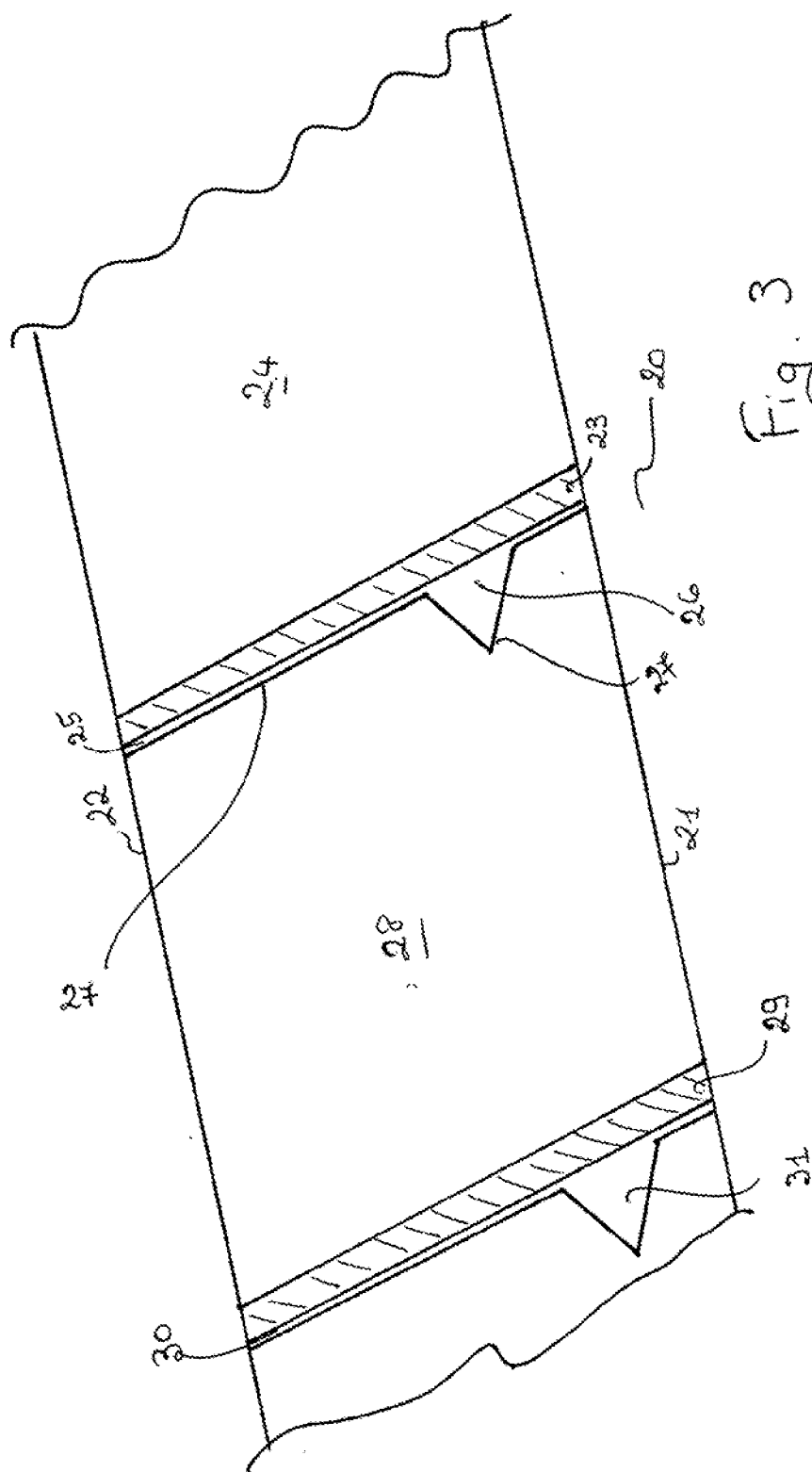
1. A plastic bag for the manufacture of an easy-openable, hermetically sealed package, said plastic bag comprising a multi-layer heat-shrinkable film folded and/or heat-sealed to itself to form a flexible container with two closed side edges, a closed  
5 bottom side edge and an open top side, wherein said multi-layer heat-shrinkable film comprises a first outer heat-sealing layer (a), a second outer layer (b) and directly adhered to the heat-sealing layer (a) an internal layer (c) of a blend of at least two resin components that are only partially compatible so that said layer (c) will fail when a transversal force of from about 4 to about 9.5 N/25.4 mm is applied thereto.
- 10 2. The plastic bag of claim 1 which comprises an unsealed area extending beyond one of the seals forming the bag, where the front and rear panels of the bag itself are separately graspable and usable as tabs to be pulled apart to initiate opening of the package.
3. The plastic bag of claim 2 wherein said unsealed area beyond one of the seals  
15 forming the bag is present only along a small portion of the seal length.
4. The plastic bag of claim 2 wherein the seal beyond which the unsealed area extends, has a width less than about 4 mm, preferably less than about 3.5 mm, and typically comprised between about 1 and about 3 mm.
5. The plastic bag of any of the preceding claims which is an ES bag.
- 20 6. A packaged product comprising i) an easy-openable, hermetically sealed, plastic bag made from a multi-layer heat-shrinkable film folded and/or heat-sealed to itself to form a closed flexible container, wherein said multi-layer heat-shrinkable film comprises at least a first outer heat-sealable layer (a), a second outer layer (b) and directly adhered to the heat-sealing layer (a) an internal layer (c) of a blend of at least  
25 two resin components that are only partially compatible so that said layer (c) will fail when a transversal force of from about 4 to about 9.5 N/25.4 mm is applied thereto, and ii) a product packaged in said bag, said plastic bag having an unsealed area

extending beyond one of the seals of the package where the front and rear panels of the bag are separately graspable and usable as opening tabs.

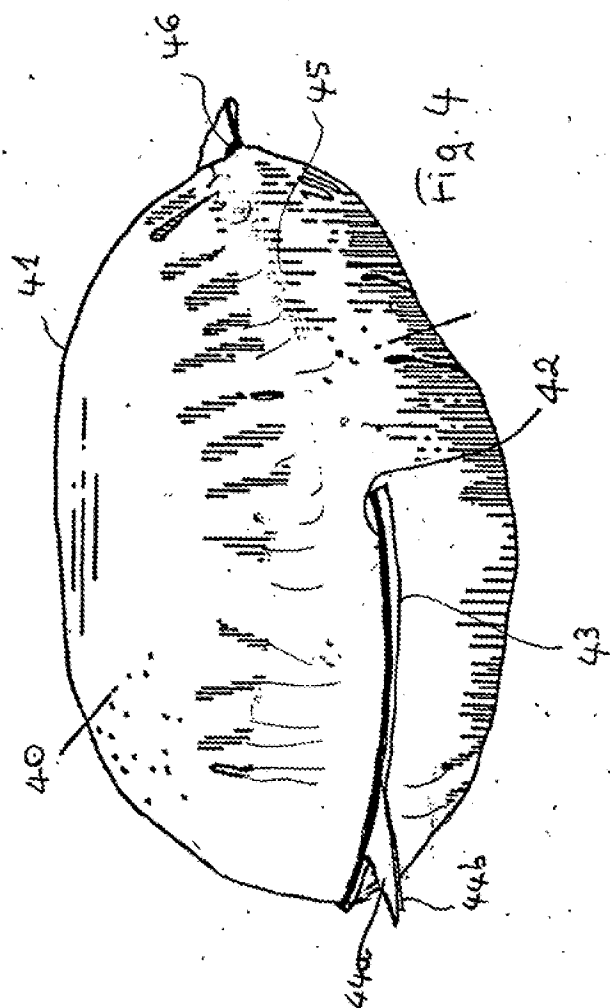
7. The packaged product of claim 6 wherein the seal in the plastic bag beyond which the unsealed area extends has a width less than about 4 mm, preferably less than about 3.5 mm, and typically comprised between about 1 and about 3 mm.
8. The package of any of preceding claims 6 and 7 wherein the plastic bag i) is an ES bag.
9. The package of claim 8 wherein the seal beyond which the unsealed area extends is the factory bottom seal.
10. The package of claim 9 wherein said unsealed area is present only along a small portion of the bottom seal length.
11. The package of any of preceding claims 6 to 10 wherein the product is packaged under vacuum and the plastic bag is heat-shrunk around the product.
12. The plastic bag of any of preceding claims 1 to 5 and the package of any of preceding claims 6 to 11 wherein the blend of resins for layer (c) comprises from about 35 wt. % to about 80 wt. % of a copolymer of ethylene and acrylic or methacrylic acid and in particular an ionomer, from about 15 wt. % to about 30 wt. % of a modified ethylene-vinyl acetate, and from about 2 wt. % to about 50 wt. % of a polybutene and preferably comprises from about 40 wt. % to about 70 wt. % of an ionomer, from about 15 wt. % to about 30 wt. % of a modified ethylene-vinyl acetate, and from about 10 wt. % to about 30 wt. % of a polybutene.

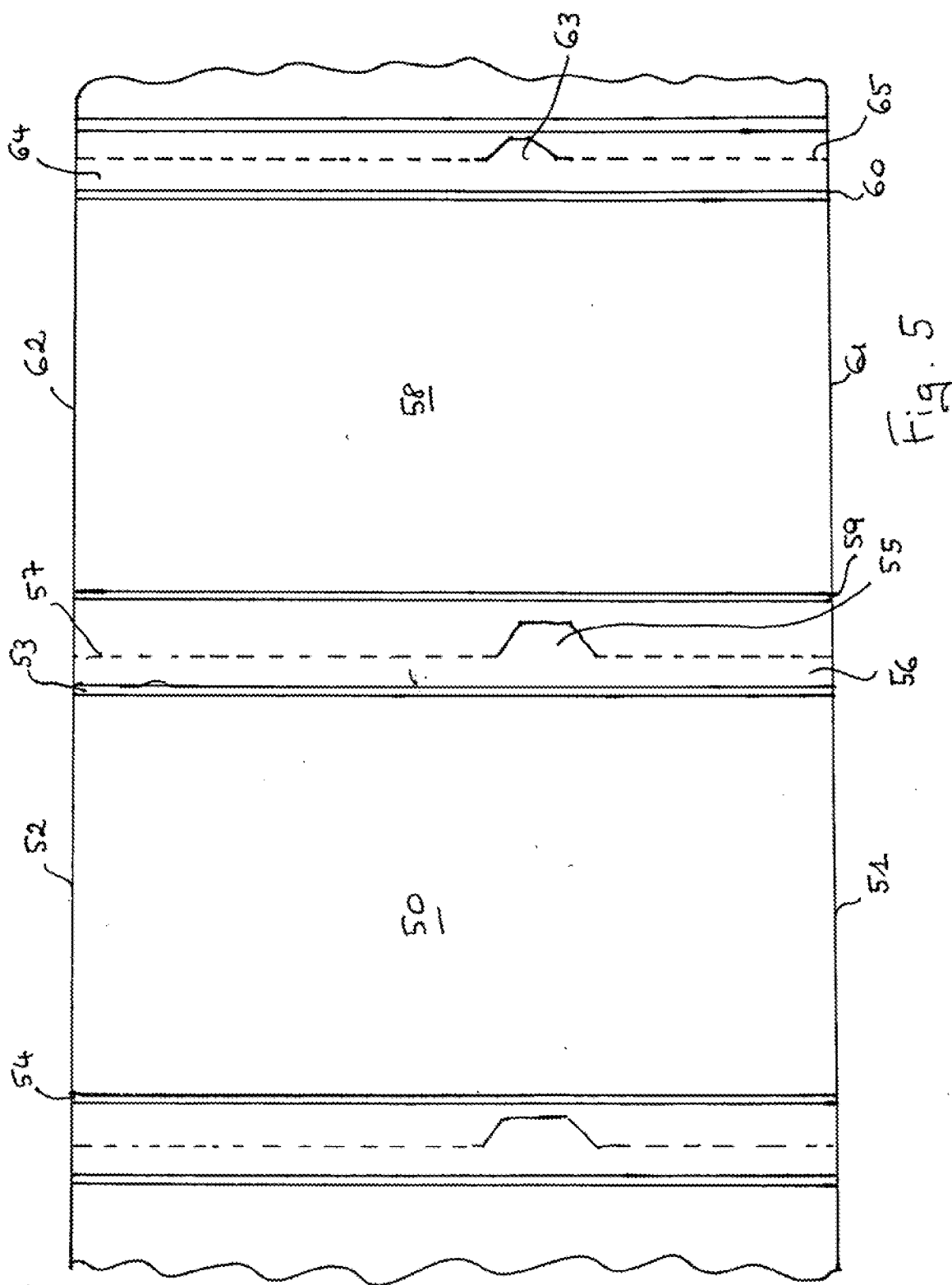






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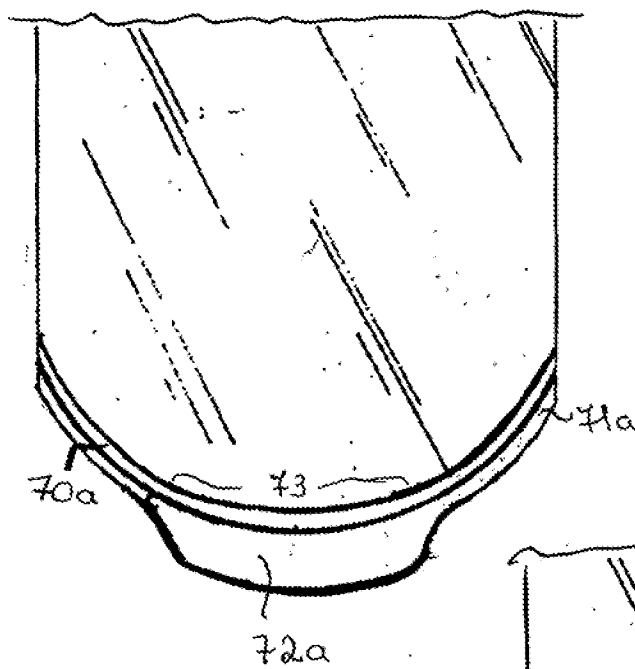


Fig. 6a

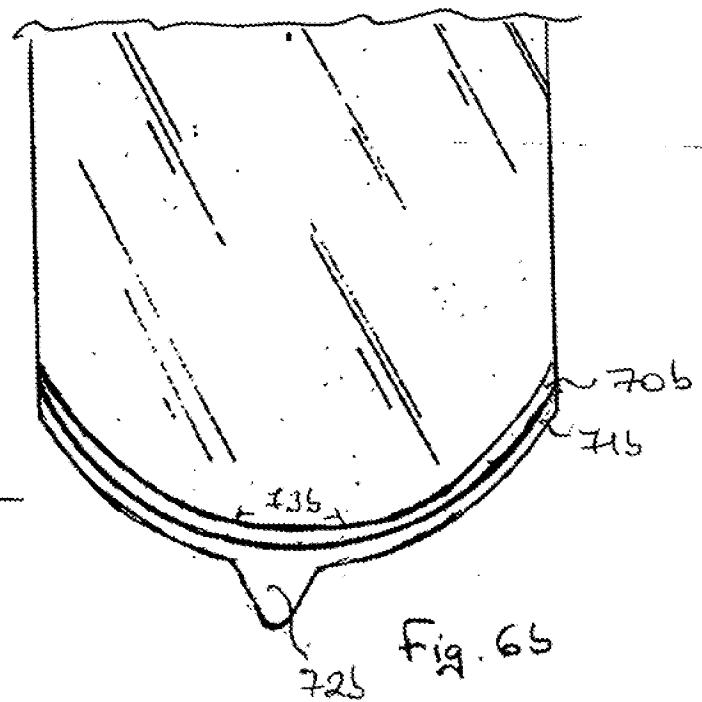


Fig. 6b

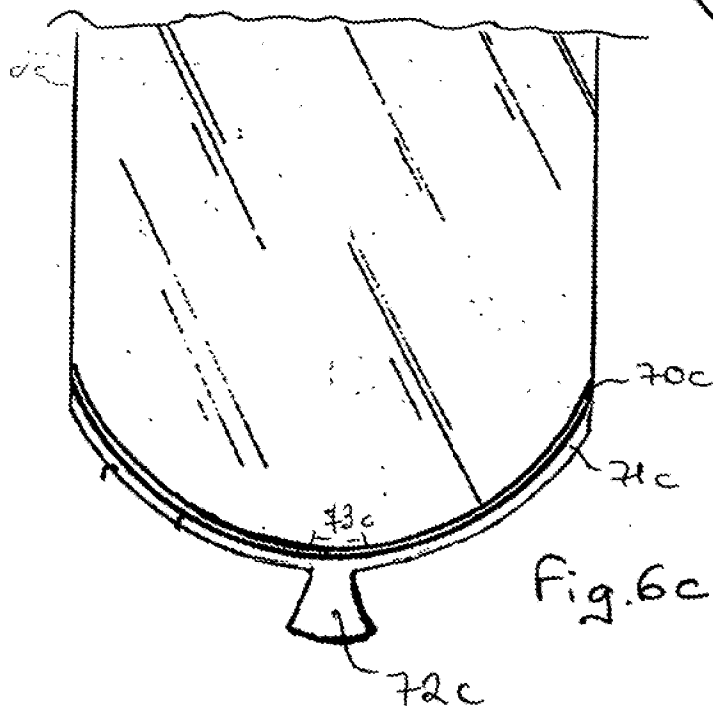


Fig. 6c

A. CLASSIFICATION OF SUBJECT MATTER  
INV. B65D75/26

According to International Patent Classification (IPC) or to both: national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B65D B31B B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/172834 A1 (RIVETT JANET W ET AL) 21 November 2002 (2002-11-21) cited in the application	6,7,11, 12
Y	the whole document	1-5,8-10
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

18 April 2007

Date of mailing of the international search report

07/05/2007

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Fitterer, Johann

## INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2007/000635

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

International application No

PCT/EP2007/000635

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